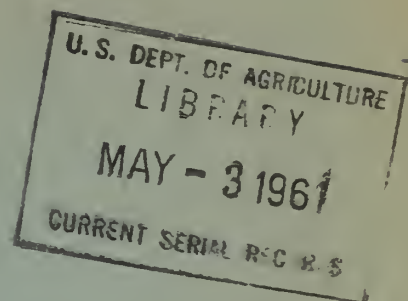


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UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION

BUREAU OF ANIMAL INDUSTRY
COOPERATING WITH
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF INDIAN AFFAIRS
AND THE
NEW MEXICO AGRICULTURAL EXPERIMENT STATION

FOURTEENTH ANNUAL REPORT
OF THE
SOUTHWESTERN RANGE AND SHEEP BREEDING LABORATORY
FORT WINGATE, NEW MEXICO

OCTOBER 31, 1950



THIS REPORT OF RESEARCH PROJECTS NOT YET COMPLETED IS INTENDED FOR THE
USE OF ADMINISTRATIVE LEADERS AND WORKERS IN THIS OR RELATED FIELDS OF
RESEARCH, AND NOT FOR GENERAL DISTRIBUTION.

1870
The first of the year
was a very dry one
and the crops were
very poor. The
winter was also very
dry and the crops
were very poor.

The second of the year
was a very wet one
and the crops were
very good. The
winter was also very
wet and the crops
were very good.

The third of the year

was a very dry one
and the crops were
very poor. The
winter was also very
dry and the crops
were very poor.
The fourth of the year
was a very wet one
and the crops were
very good. The
winter was also very
wet and the crops
were very good.

The fifth of the year
was a very dry one
and the crops were
very poor. The
winter was also very
dry and the crops
were very poor.

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ROSTER OF PERSONNEL

<u>Name</u>	<u>Title</u>	<u>Date entered on duty</u>	<u>Duties</u>
James O. Grandstaff	Animal Husbandman	Jan. 13, 1944	Director
George M. Sidwell	Animal Husbandman	Dec. 1, 1946	Genetics
Glenn J. Spaulding	Animal Fiber Tech.	Aug. 1, 1949	Wool Invest- igations
Donald A. Price	Animal Husbandman	Mar. 21, 1949	Sheep Invest- igations
Gene L. Oakes	Animal Husbandman	July 3, 1950	Sheep Manage- ment
Orval L. Navarre*	Stockman	Feb. 6, 1947	Sheep Manage- ment
Araminta D. Costello**	Clerk-Stenographer	July 1, 1947	Clerical
Marian A. Battese	Clerk-Stenographer	July 1, 1950	Clerical
Lulu F. Henerson	Statistical Clerk	Mar. 20, 1950	Sheep Records
Jimmie Gleason	Janitor	Apr. 1, 1942	Janitor and Miscellaneous
Marion Chadacloi	Laboratory Aid	Jan. 12, 1944	Miscellaneous
Alfred Dempsey	Agricultural Aid	Dec. 23, 1945	Miscellaneous
Fred Deschene	Agricultural Aid	Oct. 2, 1947	Miscellaneous

* Resigned June 1, 1950

** Resigned June 27, 1950

OBJECTIVE

The main objective of this laboratory is the development of types of sheep which are adapted to the semi-arid range conditions of the southwest, and to the economic requirements of Navajo Indians and other sheepmen of this area. In the pursuit of this objective, basic breeding methods are employed, utility values of the wool are studied, and the selection of breeding animals is based upon production as measured under range environment. Emphasis is placed primarily on adaptability and longevity of the sheep, yield of wool and its suitability with respect to hand weaving and commercial manufacture, and the quantity and quality of lambs produced.

OUTLINE OF RESEARCH PROGRAM

In order to achieve the above objective, in the development of breeds and strains of sheep suitable to the southwestern ranges and to the economic requirements of the sheepmen, there are four active research projects under way. These projects are listed as follows:

1. Improvement of Navajo sheep by linebreeding and selection in the Navajo strain.
2. Improvement of Navajo sheep by crossbreeding and selection for the production of wool suitable for both hand and commercial methods of manufacture.
3. Improvement of Navajo sheep by crossbreeding and selection for range production of wool and lambs.
4. Development of an efficient method of selecting animals used in the program of the Southwestern Range and Sheep Breeding Laboratory.

(NOTE: When reference is made to the above projects in the following sections of this report, only the number preceding the project title will be used.)

Research and Marketing Act Project:

RM-a-427-4 I Subtitle (BAI) Evaluation of wool from sheep, goats and rabbits with respect to fabrication, felting and insulation values. Line project title: Properties of blanket and rug wools of known genetic origin and history in relation to their use in fabrication, felting and insulating values.

PUBLICATIONS

The following papers have been published since the establishment of the Southwestern Range and Sheep Breeding Laboratory:

1. The Navajo Sheep Industry and Needs for Its Improvement:
J. M. Cooper, the Sheep Breeder, May 1939.
2. The Sheep Industry of Indians in the Southwest;
J. M. Cooper and Dewey Dismuke, Indians At Work, August 1939.
3. Breeding for Adaptability to Local Conditions, with Special Reference to Sheep on the Navajo Indian Reservation;
J. M. Cooper, American Society of Animal Production, 1939.
4. Improvement of the Navajo Sheep;
Cecil T. Blunn, Journal of Heredity, March 1940.
5. Breeding for Quality Wool;
James O. Grandstaff, The National Wool Grower, July 1940.
6. A Rapid Method for Projecting and Measuring Cross Sections of Wool Fibers;
James O. Grandstaff and Walter L. Hodde, Circular No. 590, U. S. Department of Agriculture, December 1940.
7. Evaluating Fleece Characteristics of Navajo Sheep from a Breeding Standpoint;
James O. Grandstaff, Rayon Textile Monthly, October-November 1941.
8. Wool Characteristics in Relation to Navajo Weaving;
James O. Grandstaff, Technical Bulletin No. 790, U. S. Department of Agriculture, January 1942.
9. Characteristics and Production of Old-Type Navajo Sheep;
Cecil T. Blunn, Journal of Heredity, May 1943.
10. The Influence of Seasonal Differences on the Growth of Navajo Lambs;
Cecil T. Blunn, Journal of Animal Science, February 1944.
11. A Preliminary Report on the Post-natal Development of the Fiber Characteristics of the Fleeces of Navajo Sheep;
James O. Grandstaff and Cecil T. Blunn, Journal of Animal Science, May 1944.
12. Comparison of the Yields of Side Samples from Weanling and Yearling Sheep;
Cecil T. Blunn and James O. Grandstaff, Journal of Animal Science, May 1944.
13. Yearly Differences in Growth of Navajo and Crossbred Ewe Lambs;
Cecil T. Blunn, Journal of Animal Science, August 1945.

14. Evaluating Fleece Quality of Navajo Sheep from Small Samples;
James O. Grandstaff and Cecil T. Blunn, Journal of Agricultural Research, September 1945.
15. Improvement of Wool for Navajo Hand Weaving;
James O. Grandstaff and Cecil T. Blunn, Indians at Work, March 1945.
16. Relation of Kemp and Other Medullated Fibers to Age in the Fleeces of Navajo and Crossbred Lambs;
James O. Grandstaff and Harold W. Wolf, Journal of Animal Science, May 1947.
17. Comparison of Corriedale x Navajo and Romney x Navajo Crosses;
James O. Grandstaff, Journal of Animal Science, November 1948.
18. Size of Lambs at Weaning as a Permanent Characteristic of Navajo Ewes;
George M. Sidwell and James O. Grandstaff, Journal of Animal Science, August 1949.
19. Adaptation of Livestock to New Environments; James O. Grandstaff,
for publication in Proc. United Nations Scientific Conference on Conservation and Utilization of Resources, Lake Success, New York, 1949.
20. Fertility and Reproduction in Sheep in Relation to Breeding and Environment;
James O. Grandstaff, presented at International Symposium on High Altitude Biology held at Lima, Peru, South America, November 23-30, 1949.
21. Genetic and Environmental Factors Affecting Staple Length in Navajo and Navajo Crossbred Weanling Lambs;
George M. Sidwell, James O. Grandstaff and Donald A. Price, Journal of Animal Science, February 1951.
22. Lamb Production of Navajo Ewes Bred to Columbia and Romney Rams, and Navajo Crossbred Ewes Bred to Lincoln and Cotswold Rams;
Donald A. Price, James O. Grandstaff and George M. Sidwell, Journal of Animal Science, February 1951.
23. Genetic and Environmental Factors Affecting Type and Condition in Navajo and Navajo Crossbred Weanling Lambs;
George M. Sidwell, Donald A. Price and James O. Grandstaff, Journal of Animal Science, May 1951.

SUMMARY OF PRECIPITATION

Year	Precipitation in Inches												Total
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
1864-1911	0.96	1.42	1.02	0.98	0.58	0.69	2.34	2.31	1.37	1.05	0.76	0.97	14.45
1938	0.52	0.79	1.95	0.43	0.61	1.67	0.78	1.84	0.85	0.10	0.67	0.24	10.47
1939	1.96	0.62	0.64	1.57	0.29	Tr.	0.85	1.23	1.31	0.30	0.10	1.22	10.09
1940	0.76	0.53	0.59	0.53	0.61	1.00	0.48	1.92	2.05	2.15	0.89	2.14	13.65
1941	0.89	1.12	1.80	1.46	2.10	0.76	0.71	1.75	4.05	2.40	0.73	0.70	18.47
1942	0.33	1.04	0.75	0.96	0.00	0.00	0.64	1.87	1.31	1.71	0.15	1.17	9.93
1943	1.48	0.24	1.61	0.46	0.28	0.41	2.30	1.94	0.30	1.65	Tr.	0.88	11.55
1944	0.64	0.71	1.07	0.21	0.87	0.14	1.10	1.91	0.99	1.49	0.93	1.42	11.48
1945	0.72	0.25	0.96	0.44	0.05	0.21	2.70	3.63	0.05	1.78	0.00	2.03	12.82
1946	0.49	0.07	0.25	0.72	Tr.	0.05	2.22	4.89	1.98	0.65	1.51	0.46	13.29
1947	0.48	0.10	0.12	Tr.	2.08	0.41	1.31	4.32	0.76	1.22	1.17	0.57	12.64
1948	0.24	1.19	1.15	0.13	0.58	1.09	2.38	2.23	1.14	0.69	0.17	1.64	12.63
1949	1.33	0.50	0.53	0.23	0.39	0.80	2.13	1.53	1.53	0.82	0.00	0.95	10.74
1950	0.63	1.01	0.17	0.00	0.02	0.25	1.52	0.56	1.24	0.00	0.52	0.14	6.06
1938-1950	0.80	0.63	0.89	0.55	0.61	0.52	1.47	2.28	1.35	1.15	0.57	1.04	11.83

The preceding table summarizes the precipitation at Fort Wingate, New Mexico, for the 47-year period 1864-1911 and for individual years from 1938 to 1950 inclusive. In 1950 the total precipitation of 6.06 inches was 53.40 percent below the average of the preceding 11 years, and 58.06 percent below the 47-year average.

The drought of 1950, the most severe on record for northwestern New Mexico, resulted in an acute shortage of range forage and water, with adverse effects on wool and lamb production. Ranges remained brown throughout May and June and most of the stock watering tanks that were dependent upon surface water for replenishment went dry, necessitating the hauling of water and provision of supplemental feed for the sheep. Rainfall during the early part of July, although light and spotty, enabled perennial grasses to make some growth. The improvement in range conditions was of short duration however, as dry weather persisted throughout August and most of September. Range forage available at the end of the growing season was inadequate to permit the sheep to be maintained at Fort Wingate during the fall and winter months. With poor range conditions prevailing throughout most of New Mexico and adjoining areas it became necessary to move the sheep outside the drought area in order to secure pasture. The ewes and lambs, numbering about 2400 head, were shipped by railroad on September 28, 1950 to a ranch near Towner, Colorado for wintering.

Adverse conditions resulting from the drought reduced both wool and lamb production of the experimental flock in 1950. The lack of green herbage for the ewes during May and June reduced their milk production to the extent that the growth and development of lambs was sharply retarded. Many ewes with twin lambs could not support both of them on the available feed, and lambs left to shift for themselves either died or were severely stunted. Weights of the lambs at weaning time were approximately 15 pounds below the average of preceding years. Clean fleece weights averaged about 10 percent below the 1949 level, a year in which precipitation was below normal. A review of the sections of this report concerned with lamb production, and the characteristics of the weanling lambs, yearling ewes and rams, will clearly reveal the influence of environmental conditions during 1950.

OUTLINE OF BREEDING PROGRAM

<u>Number of Breeding Group</u>	<u>Breeding of Rams</u>		<u>Breeding of Ewes</u>
1	N	x	N
2	R ₁	x	N
3	K	x	N
6	L	x	$\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} x \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$
7	C ₂	x	$\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} x \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$
8	$C_2 x \begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} x \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$	x	K x N
9	K x N	x	$C_2 x \begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} x \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$
10	R ₁ x N	x	$L x \begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} x \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$
11	$L x \begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} x \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$	x	R ₁ x N
12	T	x	$\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} x \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$
13	M	x	$\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} x \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$
14	D	x	$\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} x \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$
15	R ₂	x	N
16	$(K x N) x C_2 x \begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} x \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$	x	$C_2 x \begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} x \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix} x (KxN)$

Code of Symbols for Breeds

N - Navajo
R₁ - Romney
R₂ - Rambouillet
K - Columbia

C₁ - Corriedale
C₂ - Cotswold
L - Lincoln

T - Targhee
M - Merino
D - Debouillet

SUMMARY OF BREEDING PROGRAM

The breeding flock for the 1949-1950 season consisted of 1178 ewes. This number is an increase of 10.7 percent more ewes than were bred in the 1948-1949 season.

Of the 351 Navajo ewes, 140 were mated to Navajo rams, 58 to Romney rams and 123 to Columbia rams. In addition, 30 Navajo ewes were mated to a Rambouillet ram. This new breeding group is associated with research project 3 and is designated group 15. The first three types of matings represent groups 1, 2 and 3, respectively.

Groups 6 and 7 were composed of 300 crossbred ewes having an inheritance of 1/2 Navajo, 1/4 Romney and 1/4 Corriedale. These ewes were mated to Lincoln and Cotswold rams, the Cotswold rams being used in group 7.

In group 8, 146 Columbia x Navajo ewes produced by group 3 were mated to Cotswold cross rams originating from group 7. In group 9, 107 ewes were mated. This breeding group is a reciprocal of group 8, in that Columbia x Navajo rams were mated to Cotswold cross ewes.

In group 10, 138 Lincoln cross ewes were mated to Romney x Navajo rams produced by group 2. The ewes originated in group 6. The 86 matings in group 11 were the reciprocal of the matings in group 10.

In addition to the new group 15, mentioned above, groups 12, 13 and 14 are also associated with project 3. One hundred and twenty six ewes, with fleeces grading 1/2 blood or finer, from that portion of the flock previously mated to Cotswold and Lincoln rams were mated to Targhee, Merino and Debouillet rams. The Targhee, Merino and Debouillet crosses are designated as groups 12, 13 and 14, in the order listed.

Breeding group 1 is associated with research project 1, and breeding groups 2 to 11, inclusive, are associated with project 2.

The progeny of groups 8 and 9 make up the newly formed breeding group 16. These 24 yearling ewes were mated to a yearling ram from group 9. This breeding group is the final cross in one phase of the research project 2.

Progeny Testing of Crossbred Ram Lambs

In the 1949-1950 breeding season ram lambs were mated to 113 ewes, divided at random into 5 pens of about equal numbers. Three rams from group 8 and 2 rams from group 9 were used. The test pen ewes originated from previous test pen matings or range breeding. The progeny of each ram lamb was evaluated so as to obtain a record of their breeding performance.

SUMMARY OF BREEDING PENS

Breeding Group	Pen No.	Ram No.	Breeding of Rams	Breeding of Ewes	No. of Ewes
1	1	2I	N	N	32
1	2	58J	N	N	36
1	3	145K	N	N	35
1	4	58K	N	N	37
2	W12	19-46	R ₁	N	35
2	W13	17-45	R ₁	N	23
3	W14	5079K	K	N	30
3	W15	5256K	K	N	31
3	W16	5355K	K	N	31
3	W17	5526K	K	N	31
6	W5	51-46	L	$\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} \times \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$	32
6	W6	371	L	$\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} \times \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$	34
6	W7	468	L	$\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} \times \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$	23
6	W8	108-46	L	$\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} \times \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$	22
7	W9	37-47	C ₂	$\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} \times \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$	34
7	W10	365	C ₂	$\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} \times \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$	33
7	W11	1381	C ₂	$\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} \times \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$	22
8	W18	131WJ	C ₂ x $\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} \times \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$	K x N	38
8	W19	666WJ	C ₂ x $\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} \times \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$	K x N	36
8	W20	119WK	C ₂ x $\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} \times \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$	K x N	36
8	W21	493WK	C ₂ x $\begin{pmatrix} C_1 & x & N \\ R_1 & x & N \end{pmatrix} \times \begin{pmatrix} R_1 & x & N \\ C_1 & x & N \end{pmatrix}$	K x N	36

SUMMARY OF BREEDING PENS (con't.)

Breeding Group	Pen No.	Ram No.	Breeding of Rams	Breeding of Ewes	No. of Ewes
9	W22	56WJ	K x N	$C_2 \times \left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right)$	36
9	W23	334WJ	K x N	$C_2 \times \left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right)$	37
9	W24	219WK	K x N	$C_2 \times \left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right)$	34
10	W25	660WJ	$R_1 \times N$	$L \times \left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right)$	33
10	W26	107WJ	$R_1 \times N$	$L \times \left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right)$	34
10	W27	36WK	$R_1 \times N$	$L \times \left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right)$	35
10	W28	629WK	$R_1 \times N$	$L \times \left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right)$	36
11	W29	72WK	$L \times \left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right)$	$R_1 \times N$	29
11	W30	409WK	$L \times \left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right)$	$R_1 \times N$	29
11	W31	701WK	$L \times \left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right)$	$R_1 \times N$	28
12	W33	3403-T	T	$\left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right)$	31
12	W34	3512-T	T	$\left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right)$	31
13	W32	3A-45	M	$\left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right)$	33
14	W35	D-1	D	$\left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right)$	31
15	W36	93	R_2	N	30
16	W37	620WK	$\left[\begin{smallmatrix} (K \times N) \times \\ C_2 \times \left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right) \end{smallmatrix} \right] \left[C_2 \times \left(\begin{smallmatrix} C_1 & \times & N \\ R_1 & \times & N \end{smallmatrix} \right) \times \left(\begin{smallmatrix} R_1 & \times & N \\ C_1 & \times & N \end{smallmatrix} \right) \right] \times (K \times N)$		24

MEASUREMENT OF BODY WEIGHTS, SCORES, FLEECE CHARACTERISTICS AND SELECTION PROCEDURE

In 1950, the lambs were born during the month of May in the breeding corrals at the laboratory headquarters. They were weaned August 29 and 30 at approximately 120 days of age. At weaning time, each lamb was weighed individually and this weight recorded to the nearest pound. Face covering, type, condition and outercoat scores were taken by a committee of two experienced animal husbandmen, working independently. Also, color scores and degree of horn development was recorded.

The yearling rams and ewes were scored for face covering, color and outercoat just prior to shearing in April. Early in June, body weights, type and condition scores were taken. These weights and scores were taken in a manner similar to that described for the weanling lambs.

Culling of the weanling lambs was done in September. The lambs were sorted by sex into their respective breeding pens to facilitate the work of selection. The lambs of each pen were considered individually for all traits evaluated at weaning time. Also, each pen of lambs was scored as a group for size, type, condition, face covering, and fleece quality and for uniformity in these characteristics. The degree of selection practiced on each pen of lambs depended upon the individual merit of the lambs and the quality and uniformity of the pen of lambs as a group. Due to the drouth conditions, a smaller percentage of lambs was saved in 1950 than in previous years. Because of the small size of many of the lambs, it was believed these lambs would never develop satisfactorily for breeding flock replacements.

Small fleece samples collected from the middle of the left side and the thigh of each lamb at weaning age were used for measurements of their fiber characteristics. Average fiber diameter and percentages of kemp and other medullated fibers at side and thigh were determined from magnified cross-sections of the fibers, by the rapid count method. Staple length measurements were made on the side samples, after 84 days of growth. The period of wool growth was held constant for all lambs by shearing a small area on the middle of the left side of each lamb 84 days prior to weaning.

The fleeces of yearling ewes and rams and mature breeding rams were sampled in advance of shearing for evaluation of staple length, grade, percentages of kemp and other medullated fibers and clean yield. Staple length was measured at mid-side, while average fiber diameter and frequency of kemp and other medullated fibers were measured and recorded for both side and thigh positions. A side sample taken from skin area two inches wide by about five inches in length was processed to obtain the yield of bone-dry clean wool.

At shearing time each fleece was weighed and the weight recorded to the nearest 0.05 pound. Grease fleece weights of yearling ewes and rams were adjusted to exactly 365 days of growth. Estimated clean fleece weights were calculated by multiplying the grease fleece weight by the percentage yield of bone-dry clean wool in the side sample, and adjusting for 12 percent moisture content.

SECTION I

IMPROVEMENT OF NAVAJO SHEEP BY LINEBREEDING AND SELECTION IN THE NAVAJO STRAIN.

The objective of this project is to improve the Navajo strain of sheep for wool production and mutton conformation and to fix desirable characteristics. The Navajo sheep have greatest value as a source of inheritance for hardiness and adaptability to semi-arid ranges, high fertility and milk production. Improvement in the quality and uniformity of the Navajo sheep will increase their usefulness for crossbreeding with improved breeds.

Data on the characteristics and production of Navajo ewes and rams, and the traits of their weanling and yearling progeny are summarized in this section.

The data on weanling lambs has been adjusted to a constant age and for differences due to type of birth and rearing, and for age of dam.

CHARACTERISTICS OF NAVAJO BREEDING RAMS

Fleece characteristics of Navajo rams mated to Navajo ewes in the years 1947 through 1950 are summarized in the following table. The data were taken on all rams at yearling age. Rams have been selected consistently for well-improved fleeces grading 46s, 48s or 50s, free from kemp fibers.

Year	No. of rams	Age of rams at breeding (years)	Fleece weights as yearlings		Yearling Fiber Traits at Side		
			Grease (lbs.)	Clean (lbs.)	Grade	Staple length (cms.)	Medullated fibers (percent)
1947	3	2.0	6.98	4.93	50s	17.2	1.1
1948	4	2.0	7.56	5.02	48s	18.4	.0
1949	4	3.0	7.15	4.86	48s	17.8	.0
1950	4	1.7	6.93	4.39	48s	13.9	1.8
Total & Averages	15	2.2	7.17	4.79	48s	16.8	.7

CHARACTERISTICS OF NAVAJO BREEDING EWES

The following table summarizes the characteristics of the Navajo ewes bred to Navajo rams in the years 1947 through 1950.

Year	No. of Ewes	Age of Ewes at lambing (yrs.)	Body wt. at 18 months (lbs.)	Fleece weights as yearlings		Fiber Traits at Side			
				Grease (lbs.)	Clean (lbs.)	Grade	Staple length (cms.)	Kemp (per- cent)	Other Med. fibers (percent)
1947	114	5.7	96.7	4.60	3.18	58s	9.5	0.9	1.7
1948	120	7.4	99.4	5.34	3.68	58s	9.0	0.6	0.6
1949	132	5.0	101.1	5.51	3.64	58s	10.0	0.3	0.8
1950	140	5.1	102.8	5.68	3.69	58s	10.2	0.2	1.2
Total & Aver- ages	506	5.8	100.2	5.31	3.56	58s	9.7	0.5	1.1

Comparison of the data by years reveals a gradual increase in average body weights, fleece weights and staple length, with a decrease in the quantity of kemp. The selection of Navajo ewes has been restricted, however, in order to permit some increase in numbers.

LAMB PRODUCTION OF NAVAJO MATINGS

Year	No. of ewes bred	Percent of ewes lambing	Percent of lambs born of ewes bred	Percent of lambs weaned of ewes bred	Percent of lambs weaned of live lambs born.	Average weaning wt. in pounds	Pounds of lamb per ewe bred
1937-41	1745	88.3	105.1	97.3	92.5	57.0	55.4
1942-46	852	88.6	130.0	109.7	84.4	58.1	63.8
1947	118	83.9	125.4	117.8	92.0	60.5	71.9
1948	123	78.9	128.5	103.3	80.4	57.3	64.4
1949	133	85.0	116.5	93.2	80.0	56.4	52.6
1950	140	61.4	78.3	68.1	87.0	42.4	28.9
1947-50	514	76.8	110.7	94.0	84.9	55.8	52.4

The 1950 lamb production of Navajo ewes mated to Navajo rams is summarized in the above table. For purposes of comparison, the first and second 5 year averages are included along with the combined averages for the last 4 years.

The average weaning weights shown for the first two 5 year periods constitute unadjusted individual weights of the lambs at an age of about 140 days.

The percent of ewes lambing of ewes bred for 1950 was considerably below any past comparative average shown, chiefly because of the low fertility of one ram. Semen tests of the particular ram failed to show any abnormal samples, nor was there any indication of low fertility in this ram during the breeding season.

Percentages of lambs born, weaned and pounds of lamb weaned of ewes bred were also below previous averages; the main factor responsible was the low percent of pregnant ewes.

Considering the serious drouth conditions, the average figure for percent of lambs weaned of live lambs born was very good as compared to other years. In 1950 approximately 7 percent more lambs were weaned of live lambs born, than in either 1948 or 1949.

Growth of the lambs was sharply retarded by unfavorable nutrition with the result that the average weaning weight in 1950 was 14 pounds below the 1949 figure. The weaning weights of Navajo lambs were influenced less by the drouth than were any of the crossbred lambs produced in 1950.

FACE AND BODY SCORES OF NAVAJO WEANLING LAMBS

RAM LAMBS					EWE LAMBS			
Year	No. of lambs	Face covering (score)	Type (score)	Condition (score)	No. of lambs	Face covering (score)	Type (score)	Condition (score)
1947	56	2.71	3.50	3.61	80	2.72	3.19	3.15
1948	73	2.83	3.10	2.88	59	2.76	3.04	2.73
1949	66	2.64	3.09	3.00	58	2.65	3.22	2.92
1950	54	2.44	3.36	4.38	40	2.33	3.23	4.02
Total & Averages	249	2.67	3.25	3.40	237	2.65	3.17	3.14

In the above table, face and body scores have been summarized by sex and years.

In the past four years the Navajo lambs have shown steady improvement with respect to face covering. Navajo lambs of both sexes had less face covering than crossbred lambs.

A sharp drop in condition scores of lambs may be noted in 1950 from those scores of 1949. The milk production of the ewes was sharply curtailed by the extended drouth. Ewes and lambs were forced to cover large areas during the daily grazing period in order to obtain water and forage. The decrease in type scores was small as compared to last year. Lack of condition in the lambs probably influenced this trend in type scores to some extent. Both ewe and ram lambs were affected about the same by the drouth.

FLEECE CHARACTERISTICS OF NAVAJO WEANLING LAMBS

Data on fleece characteristics of Navajo weanling lambs for the years 1947 through 1950 are summarized in the next table. In 1947 staple length was measured at a constant age of 111 days, and in each of the years 1948, 1949 and 1950 staple length was measured at 84 days of growth. These differences should be considered in comparing the means of the **four** years.

The percentages of kemp and other medullated fibers have been maintained at low levels but without any appreciable change during the past four years. Complete elimination of these objectionable fibers by selection withing the Navajo strain will undoubtedly be difficult to achieve.

The outercoat scores for the Navajo lambs indicate that the amount of coarse hair fiber is being gradually reduced through selection of breeding rams.

Year	No. of lambs	Grade	Staple length (cms.)	Kemp (percent)	Other Med. fibers (percent)	Outercoat (score)	a/
1947	137	56s	4.7	0.0	0.4	-	
1948	125	56s	3.4	.3	3.2	3.78	
1949	124	50s	4.1	.2	2.1	3.18	
1950	94	56s	3.3	.3	4.3	3.36	
Total & Averages	591	56s	4.0	.2	2.7	3.44	

a/ Scores for outercoat not taken prior to 1948.

SELECTION PRACTICED ON NAVAJO LAMBS

The percentages of Navajo lambs saved, by sexes, the selection differentials for all traits considered at weaning age, the relative emphasis placed on each trait at culling time, and the expected genetic gains are given in the following table:

The number of Navajo ewe lambs saved in 1950 was 14 percent less than in 1949. Selection was greatly limited due to the small size of the lambs. The number of ram lambs saved was almost as large as in 1949. Only a small number of ram lambs are retained each year.

The relative emphasis among the various traits for the ram lambs was greatest for weaning weight, followed by staple length and color. In ewe lambs the most emphasis was placed on weaning weight, followed by staple length and condition. In general, selection differentials were larger for more traits in 1950 than in 1949; weaning weights were an exception to this observation.

The estimates of genetic gains in the following tables for each research line project are an indication of how much the selected lambs are superior in actual breeding value to the unselected groups from which they were chosen. The heritability values used in the calculation of the estimates of genetic gains are those obtained for range Rambouillet lambs at Dubois, Idaho. Thus these estimates are valid only to the extent that these heritability estimates are applicable to the lambs at this station.

SELECTION DIFFERENTIALS, RELATIVE EMPHASIS, AND EXPECTED GENETIC GAIN FOR NAVAJO WEANLING LAMBS

	Weaning weight (lbs.)	Staple length (cms.)	Fiber diameter (microns)	Face covering (score)	Body type (score)	Condition (score)	Color (score)	Outer- coat (score)	Percent saved
Rams									
Advantage of selected lambs	2.42	.40	-.70	.16	.02	.11	.59	.21	16.67
Relative emphasis	.39	.52	-.23	.30	.04	.22	.55	.29	
Expected genetic gain	.73	.16		.09	.00	.00			
Ewes									
Advantage of selected lambs	1.38	.10	.40	.01	.00	.21	.00	.14	65.00
Relative emphasis	.24	.20	.17	.02	.00	.44	.00	.19	
Expected genetic gain	.41	.04		.01	.00	.01			

BODY WEIGHTS AND SCORES OF NAVAJO YEARLING RAMS

Year	No. of rams	Body weight (lbs.)	Face covering (score)	Type (score)	Condition (score)	Color (score)	Outer- coat (score)
1947	2	115.0	2.25	3.17	3.09	1.50	-
1948	6	115.2	2.23	3.20	2.96	1.17	-
1949	14	112.3	2.33	2.89	2.64	1.36	2.24
1950	10	103.5	2.60	3.00	2.97	1.50	2.07
Total & Averages	32	110.3	2.39	3.00	2.83	1.38	2.17

The body weights of the rams do not show as sharp a drop as the weights of the ewes. No doubt the dry lot feeding of the rams during a portion of the year aids in maintaining their size. However, the very dry spring in 1950 exhibits its effect as the rams are approximately 9 pounds below the 1949 figure for average body weight.

It may be noted that the face, color and body scores have remained essentially the same during the past 4 years. The number of lambs available to select from, of straight Navajo breeding, is small. A large number of Navajo ewes in recent years have been allotted to purebred rams in the crossbreeding program.

FLEECE CHARACTERISTICS OF NAVAJO YEARLING RAMS

Data on various fleece characteristics of Navajo yearling rams for the years 1947-1950 are summarized below. The fleeces of all rams were free from kemp fibers. Selection against coarse outercoat and kemp fibers has greatly improved fleece quality and uniformity, but at the same time it has reduced the effectiveness of selection for fleece weight and staple length. Average values for fleece weight, grade and staple length in 1950 compare favorably with the other years.

Year	No. of rams	Fleece weights		Grade	Fiber Traits at Side	
		Grease (lbs.)	Clean (lbs.)		Staple length (cms.)	Medullated Fibers (percent)
1947	2	7.18	4.70	46s	14.8	0.0
1948	6	6.65	3.88	48s	15.0	1.2
1949	14	6.43	4.30	56s	11.6	.1
1950	10	6.56	3.92	56s	12.6	.0
Total & Averages	32	6.56	4.13	50s	12.8	.3

BODY WEIGHTS AND SCORES OF NAVAJO YEARLING EWES

Year	No. of ewes	Body weight (lbs.)	Face Covering (score)	Type (score)	Condition (score)	Color (score)	Outer-coat (score)	a/
1947	39	84.6	2.07	3.29	3.13	2.46	-	
1948	75	86.8	2.58	2.97	2.68	1.32	-	
1949	55	77.9	2.31	2.74	2.49	1.72	3.08	
1950	46	75.7	2.43	2.84	2.91	1.30	3.05	
Total & Averages	215	81.8	2.39	2.94	2.76	1.63	3.07	

a/ Outercoat scores not taken prior to 1949.

The body weights of the yearling ewes for the past 2 years have dropped sharply below the previous 2-year period. While the ewes show no drastic drop in condition and type scores, the body size has decreased due to less favorable environmental conditions. In 1949, the yearling ewes were handicapped because of the necessity of herding them with the mature ewes. In 1950, due to the extremely dry spring, the range feed was not sufficient to grow these ewes out properly resulting in smaller June body weights.

The Navajo yearling ewes have improved greatly in average color score during the past 4 years. The outercoat and face scores have remained essentially the same.

FLEECE CHARACTERISTICS OF NAVAJO YEARLING EWES

Year	No. of ewes	Fleece weights		Grade	Fiber Traits at Side		
		Grease (lbs.)	Clean (lbs.)		Staple length (cms.)	Kemp (percent)	Other Mod. Fibers (percent)
1947	39	5.14	4.00	48s	11.4	0.1	3.0
1948	75	6.19	3.82	56s	12.5	.2	1.1
1949	55	5.73	3.69	58s	10.5	.5	3.0
1950	46	6.38	3.38	58s	11.4	.1	1.6
Total & Averages	215	5.92	3.72	56s	11.6	.2	2.2

Grease fleece weights of yearling Navajo ewes averaged higher in 1950 than in any of the preceding three years, however, the fleeces contained more dirt and yielded less clean wool as a result of short feed and dry ranges during the late winter and spring months. Both in 1949 and 1950 the fleeces averaged finer in fiber diameter, which was influenced no doubt by the plane of nutrition. Range conditions in the winters of 1949 and 1950 were unfavorable for growth and development of ewe lambs.

SECTION II

IMPROVEMENT OF NAVAJO SHEEP BY CROSSBREEDING AND SELECTION FOR THE PRODUCTION OF WOOL SUITABLE FOR BOTH HAND AND COMMERCIAL METHODS OF MANUFACTURE

The objective of this research project is the development of coarse-wooled strains of sheep that combine adaptability to southwestern ranges with efficient production of good quality feeder lambs and wool of 46s, 48s and 50s grades. Selection emphasis is placed primarily on adaptability and longevity of the sheep, yield of wool and its suitability with respect to hand weaving and commercial manufacture, and the quantity and quality of lambs produced.

Information on the characteristics and production of the sheep used in project 2 are presented in this section.

CHARACTERISTICS OF PUREBRED AND CROSSBRED BREEDING RAMS

Various characteristics of the breeding rams used in project 2 are presented in the following table. Breeding rams have been selected with major emphasis on fleece quality. Fleece characteristics considered are grade, staple length, uniformity, freedom from kemp and other medullated fibers, and yield of clean wool.

Purebred rams of the Romney, Columbia, Lincoln and Cotswold breeds were used in breeding groups 2, 3, 6 and 7, respectively. Crossbred rams with inheritance of either 1/2, 1/4 or 3/8 Navajo were used in groups 8, 9, 10, 11 and 16.

Clean fleece weights of the crossbred rams, although somewhat less than that of the purebred rams, exceeded an average of 6 pounds for all groups. The Cotswold cross rams of group 8 and the Lincoln cross rams of group 11, produced approximately 7.5 pounds of clean wool per head. The fleeces of crossbred rams were equivalent to grades 48s or 50s in fiber diameter, with good staple length, and free from kemp.

Breeding Group	No. of rams	Age of ram at Breeding (years)	Body Weight at breeding time (lbs.)	Fleece Weight as Yearlings		Fiber Traits at Side		
				Grease (lbs.)	Clean (lbs.)	Grade	Staple length (cms.)	Med. Fibers (percent)
2	2	3.5	182.0	11.36	8.08	40s	17.2	0.5
3	4	4.0	198.3	11.30	6.76	50s	11.6	.0
6	4	3.0	218.5	14.93	10.59	46s	20.7	2.1
7	3	2.7	192.3	17.50	12.07	40s	20.4	6.2
8	4	1.5	175.5	10.13	7.48	48s	14.2	.2
9	3	1.7	193.3	11.74	6.79	50s	12.4	.0
10	4	1.5	185.5	9.88	6.20	48s	11.4	1.0
11	3	1.0	165.7	11.08	7.54	48s	13.5	.6
16	1	1.0	163.0	8.78	6.84	50s	10.0	.0
Total & Averages	28	2.3	189.0	12.05	8.08	48s	14.8	1.2

CHARACTERISTICS OF NAVAJO AND CROSSBRED BREEDING EWES

Body weights at 18 months and yearling fleece weights and fiber characteristics of the 881 breeding ewes of project 2 are summarized below by their respective breeding groups. When making comparisons of group averages it should be remembered that the ewes of groups 2 and 3 are full-blood Navajo. All other groups are composed of crossbred ewes having inheritance of either 1/2, 3/4 or 5/8 from improved breeds.

Navajo ewes reach mature body weights at about 2 years of age. The crossbred ewes mature at 2.5 to 3 years of age, with maximum production at ages 3 and 4.

The Columbia x Navajo ewes of group 8 had the highest average body and fleece weights. Crossbred ewes sired by Cotswold and Lincoln rams, groups 9 and 10, were similar as regards body and fleece weights, and both groups ranked close to the Columbia x Navajo. Ewes of group 16, having inheritance from both the Columbia and Cotswold breeds, also had a high yield of clean wool.

Fleece grades at the side, are, as previously stated, based on the average fiber diameter at the base end of the staple, and thus are influenced by the health and plane of nutrition of the sheep during the late winter and early spring months. For information on commercial grades of fleeces, the reader is referred to the section of this report on fleece grading and sorting.

Breeding Group	No. of Ewes	Average age of ewes at breeding (yrs.)	Average body wt. at 18 mos. (lbs.)	Fleece weight as yearlings		Fiber Traits at Side			
				Grease (lbs.)	Clean (lbs.)	Grade	Staple length (cms.)	Kemp %	Other Med. fibers %
2	57	4.6	98.9	4.38	3.17	56s	10.2	0.1	1.9
3	123	4.4	97.1	4.47	3.13	56s	10.5	.2	2.8
6	111	4.5	109.6	6.60	3.77	56s	10.1	.1	2.5
7	89	4.5	105.8	6.20	3.59	50s	9.7	.2	2.4
8	146	3.0	119.2	8.01	4.78	56s	10.5	.0	1.6
9	107	3.2	115.3	7.34	4.64	50s	13.1	.0	2.4
10	138	2.4	113.4	7.29	4.45	58s	11.4	.0	1.6
11	86	2.5	110.1	6.93	3.96	58s	9.4	.0	1.2
16	24	2.0	112.1	6.96	4.62	58s	10.9	.1	2.3
Total & Averages	881	3.5	109.8	6.59	4.04	56s	10.7	.1	2.0

LAMB PRODUCTION OF CROSSBRED MATINGS

By Breeding Groups for 1950

Group	No. of ewes bred	Percent of ewes lambing	Percent of lambs born of ewes bred	Percent of lambs weaned of ewes bred	Percent of lambs weaned of l. lambs born	Average weaning weight in pounds	Pounds of lamb per ewe bred
2	58	84.5	105.2	93.1	88.5	45.4	42.3
3	123	93.5	130.6	103.3	79.1	46.5	48.0
6	111	49.6	66.7	52.3	78.4	45.4	23.7
7	89	88.8	114.6	89.9	78.4	43.2	38.8
8	146	84.9	114.5	89.7	78.3	45.3	40.6
9	107	88.8	109.4	81.3	74.4	43.9	35.7
10	138	94.2	104.4	68.8	66.0	40.8	28.1
11	86	90.7	98.8	82.4	83.3	43.4	35.7
16	24	95.8	112.5	87.5	77.8	44.3	38.8
Total & Averages	882	84.8	106.3	81.6	77.2	44.3	36.3

By 5-Year Periods

Year							
1937-41	1216	88.3	109.4	97.1	88.8	59.9	58.2
1942-46	1794	79.8	110.0	89.4	81.3	59.4	53.1

By Last 4-Year Period

1947-50	3270	77.3	102.6	83.3	81.1	59.9	49.9
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Lamb production of Navajo and Navajo crossbred ewes mated to purebred rams and crossbred rams of medium and coarse wool breeding, are presented in the preceding table. The 5 year averages and the combined averages for the last 4 years are shown.

The percentage of ewes lambing in 1950 exceeds the 4 year average in every group except group 6. The low fertility of several of the rams in group 6 was the main factor responsible for the low percentage of ewes lambing in this group. Group 16, which represents a final cross in this breeding project, shows the highest percentage of ewes lambing.

Navajo ewes mated to Columbia rams had the greatest percentage of lambs born, and also weaned more lambs than the remaining groups. The average for all groups in percentage of lambs born for 1950 was about 4 percent above the 4 year average, and for percentage of lambs weaned of ewes bred, about 2 percent below the 4 year mean.

The drop in 1950 for percentage of lambs weaned of live lambs born as compared to past averages, no doubt is due to a large extent to the severe drouth. This same climatic factor must also be considered in comparing weaning weights of lambs, and pounds of lamb produced per ewe bred. In general, those groups represented by ewes which had a higher inheritance of Navajo blood were superior in lamb production the past dry year. Ewes in those groups which contain a greater amount of Navajo blood are older, however, and this must be considered when comparing them with the more recent breeding groups.

FACE AND BODY SCORES OF CROSSERED WEANLING LAMBS

RAM LAMBS					EWE LAMBS			
Group	No. of lambs	Face covering (score)	Type (score)	Condition (score)	No. of lambs	Face covering (score)	Type (score)	Condition (score)
2	31	3.17	2.71	3.74	23	2.93	2.59	3.59
3	61	2.75	2.86	3.71	64	2.71	2.93	3.79
6	30	2.92	2.92	4.14	28	2.89	2.93	4.04
7	37	3.19	3.00	4.24	43	3.04	2.99	4.05
8	63	3.07	2.87	3.81	67	2.88	2.88	3.75
9	44	3.05	3.14	4.12	43	2.81	2.91	3.85
10	51	2.99	3.09	4.20	44	2.86	2.93	3.97
11	29	3.05	2.86	3.94	41	2.90	2.84	3.84
16	12	2.61	2.94	4.03	9	2.48	2.51	3.53
Total & Averages 1950	358	2.99	2.94	3.97	362	2.85	2.88	3.85
Total & Averages 1949	311	3.04	2.45	2.51	318	2.98	2.57	2.49

Face and body scores have been summarized for sex, groups and years in the preceding table.

Face covering for ewe and ram lambs was essentially the same. Wool blindness did not impose a problem as the scores indicate. The ewe and ram lambs in group 16 were superior to all other groups with respect to face covering. The ewe lambs in group 16 also had a type score superior to the other groups regardless of sex. The ewe and ram lambs in group 2 showed good scores in both type and condition as compared to the remaining groups. The progeny from long woolled rams in 1950 had sizable frames and favorable type scores, however, as the condition scores indicate, they appeared to have less resistance to the rigorous environment imposed on them from birth to weaning time.

The face scores in 1950 show an improvement over 1949. The 1950 body scores show a sharp drop from the 1949 averages.

FLEECE CHARACTERISTICS OF CROSSBRED WEANLING LAMBS

The following table summarizes the data on fiber characteristics of the weanling lambs.

Lambs of groups 2 and 3 sired by Romney and Columbia rams were similar as regards average fleece grade. The Columbia x Navajo lambs had less staple length and a lower outercoat score than the Romney x Navajo lambs.

Groups 6 and 7, sired by Lincoln and Cotswold rams excelled in staple length, but also had the highest outercoat scores.

Groups 8, 9, 10, 11 and 16 were similar with respect to average grade and staple length. The lambs of group 16, representing the final cross, had the most improved fleeces.

Owing to the adverse conditions resulting from the drought the lamb fleeces were finer in fiber diameter, with less staple length, than the corresponding groups in 1949.

Group	No. of lambs	Grade	Fiber Traits at Side			Outer-coat (score)
			Staple length (cms.)	Kemp (percent)	Other Med. fibers (percent)	
2	54	56s	3.8	0.1	4.22	2.91
3	125	56s	3.5	.2	4.66	2.77
6	58	56s	4.5	.0	3.25	3.28
7	80	56s	4.5	.1	7.28	3.62
8	130	58s	3.9	.1	3.26	2.94
9	87	58s	3.9	.0	3.36	2.86
10	95	58s	3.9	.0	1.99	2.85
11	70	58s	3.9	.1	2.13	2.82
16	21	58s	3.7	.0	3.26	2.62
Total & Averages 1950	720	56s	3.9	.1	3.76	2.97
Total & Averages 1949	628	56s	4.3	.2	3.29	2.96

SELECTION PRACTICED ON CROSSBRED WEANLING LAMBS

In research project 2, from a total of 358 ram lambs weaned, 71 were saved. A total of 193 ewe lambs were saved, from 362 weaned. The percentages of lambs saved were considerably less than in previous years, the heavy culling being due to the small size of lambs at weaning. However, as a result of the drastic culling, larger selection differentials were obtained for most traits than in previous years. As can be seen in the following table, positive selection was practiced for nearly all characteristics. A few exceptions to this can be seen for staple length and fiber diameter; selection against kemp and coarse outercoat fibers automatically results in selective pressure against these two characteristics.

SELECTION PRACTICED ON CROSSBRED TEENLING LAMBS

Group No.	Sex		Meaning weight (lbs.)	Staple length (cms.)	Fiber diameter (microns)	Face covering (score)	Body type (score)	Condition (score)	Color (score)	Outer-coat (score)	Per-cent saved
2	Rams	Advantage of selected lambs	2.98	.00	-.80	.28	.13	.38	.30	.34	35.48
		Relative emphasis	.47	.00	-.27	.47	.23	.66	.42	.42	
		Expected genetic gain	.89	.00	-	.16	.02	.02	-	-	
	Ewes	Advantage of selected lambs	4.35	.20	1.70	.12	.09	.28	.20	.16	52.17
	Relative emphasis	.64	.22	.54	.30	.21	.44	.21	.26		
	Expected genetic gain	1.30	.08	-	.07	.01	.01	.01	-	-	
3	Rams	Advantage of selected lambs	2.54	-.20	-.50	-.06	.04	.29	-.17	.39	22.95
		Relative emphasis	.36	-.27	-.34	-.12	.08	.53	-.26	.55	
		Expected genetic gain	.76	-.08	-	-.03	.01	.01	-	-	
	Ewes	Advantage of selected lambs	2.70	.00	-.10	.01	.14	.29	-.06	.31	46.88
	Relative emphasis	.38	.00	-.05	.02	.29	.54	-.08	.49		
	Expected genetic gain	.81	.00	-	.01	.02	.01	-	-		
6	Rams	Advantage of selected lambs	4.39	.20	.70	.04	.12	.11	.30	-.16	26.67
		Relative emphasis	.63	.25	.14	.07	.31	.21	.44	-.23	
		Expected genetic gain	1.32	.80	-	.02	.02	.00	-	-	
	Ewes	Advantage of selected lambs	2.36	.00	.10	-.01	.05	.14	-.12	.19	60.71
	Relative emphasis	.37	.00	.04	-.02	.12	.24	-.11	.34		
	Expected genetic gain	.68	.00	-	-.01	.01	.01	.01	-	-	

SELECTION PRACTICED ON CROSSBRED WEANLING LAMBS, CONT.

Group No.	Sex		Weaning weight (lbs.)	Staple length (cms.)	Fiber diameter (microns)	Face covering (score)	Body type (score)	Condition (score)	Color (score)	Outer-coat (score)	Per-cent saved
7	Rams	Advantage of selected lambs	5.79	.10	.00	-.21	-.17	.09	.13	.20	13.51
		Relative emphasis	.79	.14	.00	-.37	-.35	.20	.13	.36	
		Expected genetic gain	1.74	.04	-	-.12	-.02	.00	-	-	
	Ewes	Advantage of selected lambs	2.05	-.20	-.10	.07	.09	.21	.28	.26	51.16
		Relative emphasis	.31	-.20	-.04	.16	.21	.36	.29	.49	
		Expected genetic gain	.62	-.08	-	.04	.01	.01	-	-	
8	Rams	Advantage of selected lambs	7.54	.20	1.20	.09	.38	.22	.34	.10	14.29
		Relative emphasis	1.12	.32	.47	.20	.79	.46	.40	.17	
		Expected genetic gain	2.26	.08	-	.05	.05	.01	-	-	
	Ewes	Advantage of selected lambs	2.85	.00	-.10	.03	.03	.28	.15	.30	49.25
		Relative emphasis	.40	.00	-.04	.06	.06	.44	.16	.46	
		Expected genetic gain	.86	.00	-	.02	.00	.01	-	-	
9	Rams	Advantage of selected lambs	4.12	.20	.10	.21	.07	.28	.24	.23	20.46
		Relative emphasis	.53	.25	.04	.36	.15	.53	.30	.32	
		Expected genetic gain	1.24	.08	-	.12	.01	.01	-	-	
	Ewes	Advantage of selected lambs	2.98	.00	.20	.10	.19	.19	.32	.06	60.47
		Relative emphasis	.45	.00	.08	.09	.38	.34	.33	.18	
		Expected genetic gain	.89	.00	-	.06	.02	.01	-	-	

SELECTION PRACTICED ON CROSSED WEANLING LAMBS, CONT.

Group No.	Sex		Meaning weight (lbs.)	Staple length (cms.)	Fiber diameter (microns)	Face covering (score)	Body type (score)	Condition (score)	Color (score)	Outer-coat (score)	Per-cent saved
10	Rams	Advantage of selected lambs	10.77	.00	1.70	-.05	.11	.52	.41	.17	9.80
		Relative emphasis	1.25	.00	.71	-.09	.27	.85	.55	.31	
		Expected genetic gain	3.23	.00	-	-.03	.01	.02	-	-	
	Ewes	Advantage of selected lambs	3.71	.00	.40	.13	.18	.20	.00	.12	52.27
11		Relative emphasis	.59	.00	.21	.23	.38	.30	.00	.20	
		Expected genetic gain	1.11	.00	-	.07	.02	.01	-	-	
	Rams	Advantage of selected lambs	4.60	-.10	-.50	.05	.20	.42	.72	.37	24.14
		Relative emphasis	.59	-.14	-.24	.10	.38	.88	.58	.55	
		Expected genetic gain	1.38	-.04	-	.03	.03	.02	-	-	
	Ewes	Advantage of selected lambs	1.06	-.10	.70	.13	.15	.34	.16	.13	58.54
		Relative emphasis	.26	-.13	.26	.35	.31	.52	.16	.25	
		Expected genetic gain	.50	-.04	-	.07	.02	.01	-	-	
16	Rams	Advantage of selected lambs	5.30	.20	.00	.66	.02	.63	-.41	-.12	25.00
		Relative emphasis	.93	.38	.00	1.12	.05	1.15	-.35	-.20	
		Expected genetic gain	1.59	.04	-	.37	.00	.03	-	-	
	Ewes	Advantage of selected lambs	1.45	.20	.00	-.02	.05	.20	.11	.20	66.67
		Relative emphasis	.16	.22	.00	-.03	.07	.23	.15	.50	
		Expected genetic gain	.44	.08	-	-.01	.01	.01	-	-	

BODY WEIGHTS AND SCORES OF CROSSBRED YEARLING RAMS

While group 6 showed the heaviest yearling body weights for ewes it was the opposite picture for the rams. There was a range in weight of 9.7 pounds from the lightest, group 6, to the heaviest, group 8. Crossbred rams in group 10 also had a heavy body weight as compared to the remaining groups and were superior in face covering, type and condition scores. The number of rams in group 10 must be considered when comparing them with the other groups. The 1950 drop of 8 pounds in average yearling body weight from the 1949 average was due largely to the extremely poor spring range on which these rams were forced to subsist. As was true for the yearling ewes, the rams also were scored quite uniformly for face, color, type and condition scores. All scores were slightly below the 1949 level with the exception of the color score which was essentially the same.

The Cotswold and Lincoln crossbred rams showed the most outercoat, while groups 2, 3 and 11 were much superior to the remaining groups for outercoat score.

Group No.	No. of rams	Body weight (lbs.)	Face covering (score)	Type (score)	Condition (score)	Color (score)	Outer-coat (score)
2	17	113.5	2.79	2.38	2.46	1.41	2.00
3	21	120.0	2.52	2.38	2.40	1.19	1.80
6	13	113.1	2.48	2.47	2.76	1.23	2.86
7	13	117.8	2.78	2.56	2.81	1.62	3.04
8	13	122.8	3.08	2.31	2.49	1.38	2.80
9	16	120.2	2.90	2.30	2.64	1.44	2.54
10	4	122.5	2.25	2.00	2.38	1.50	2.50
11	5	114.0	2.97	2.64	2.70	1.40	1.84
Total & Averages 1950	102	118.0	2.75	2.39	2.57	1.37	2.40
Total & Averages 1949	98	126.0	2.63	2.21	2.20	1.38	2.56

FLEECE CHARACTERISTICS OF CROSSERED YEARLING RAMS

The fleeces of the yearling crossbred rams at shearing time were much heavier in weight, were coarser and of longer staple than those of the yearling ewes of the same breeding. The yearling rams were fed throughout the winter months prior to shearing whereas the yearling ewes were subject to more adverse conditions while grazing on the winter range. This may account for longer staple, greater fiber diameter and, in part, for the higher clean fleece weights of the rams. A greater degree of selection in the rams and sex differences also account for the higher fleece weights.

The yearling rams in groups 6, 7 and 8 have the highest grease and clean fleece weights; they also excel in length of staple.

The average fleece grade of all groups, except group 3, was either 48s or 50s, which are the preferred grades for this project.

No kemp was detected in the side samples of yearling rams. Clean fleece weights averaged .85 pound less in 1950 than in 1949. This difference was probably the result of environmental conditions.

Group	No. of rams	Fleece Weights		Grade	Fiber Traits at Side	
		Grease (lbs.)	Clean (lbs.)		Staple length (cms.)	Other Med. fibers (percent)
2	17	8.83	5.34	50s	13.3	0.0
3	21	9.41	5.32	56s	12.0	.0
6	13	9.62	6.17	50s	14.7	.1
7	13	9.73	6.08	48s	14.5	.3
8	13	9.46	5.94	50s	14.3	.6
9	16	9.39	5.49	50s	12.9	.8
10	4	9.06	5.62	50s	14.0	.0
11	5	7.62	4.56	50s	12.1	.0
Total & Averages 1950	102	9.28	5.61	50s	13.4	.2
Total & Averages 1949	101	9.40	6.46	50s	12.4	.6

BODY WEIGHTS AND SCORES OF CROSSBRED YEARLING EWES

For yearling ewe body weight there was a range of 9.0 pounds between the heaviest, group 6, and the lightest, group 2. The average body weight for all groups in 1950 was 2.3 pounds below the 1949 average.

Scores for face covering, type, condition and color were remarkably uniform throughout the yearling ewe flock. All scores mentioned were slightly below the 1949 level.

Groups 6 and 7 were scored the most undesirable for outercoat fibers in the fleece. Group 11 was scored the most improved fleece, that is freedom from outercoat. The average outercoat score for 1950 was essentially the same as the average score in 1949.

Group No.	No. of ewes	Body weight (lbs.)	Face covering (score)	Type (score)	Condition (score)	Color (score)	Outer-coat (score)
2	38	78.4	2.85	2.38	2.60	1.47	2.40
3	42	83.1	2.62	2.32	2.39	1.12	2.39
6	31	87.4	2.68	2.29	2.68	1.61	3.39
7	32	82.1	2.96	2.41	2.75	1.28	3.26
8	32	85.3	2.84	2.37	2.55	1.69	2.84
9	26	85.2	2.82	2.38	2.65	1.50	2.91
10	4	78.5	2.63	2.39	2.70	1.00	3.17
11	14	82.8	2.98	2.35	2.53	1.21	2.07
Total & Averages 1950	219	83.1	2.80	2.36	2.59	1.41	2.78
Total & Averages 1949	260	85.4	2.34	2.22	2.27	1.38	2.74

FLEECE CHARACTERISTICS OF CROSSBRED YEARLING EWES

Data on various fleece characteristics of 219 yearling crossbred ewes are summarized on next table.

The mean grease fleece weight of the 8 groups was 1.08 pounds above the 1949 average but clean fleece weight was .57 pounds less than in the preceding year. Sort feed and dry range conditions contributed to higher shrinkage and decreased yields of clean wool. The fleece grade of all groups was finer than would be expected under a high plane of nutrition.

1. The first part of the report is a general statement of the work done during the year.

2. The second part of the report is a detailed account of the work done during the year.

3. The third part of the report is a summary of the work done during the year.

4. The fourth part of the report is a list of the names of the persons who have been employed during the year.

5. The fifth part of the report is a list of the names of the persons who have been employed during the year.

1.	2.	3.	4.	5.	6.	7.	8.
1.	2.	3.	4.	5.	6.	7.	8.
1.	2.	3.	4.	5.	6.	7.	8.

1.	2.	3.	4.	5.	6.	7.	8.
1.	2.	3.	4.	5.	6.	7.	8.
1.	2.	3.	4.	5.	6.	7.	8.
1.	2.	3.	4.	5.	6.	7.	8.
1.	2.	3.	4.	5.	6.	7.	8.

1.	2.	3.	4.	5.	6.	7.	8.
1.	2.	3.	4.	5.	6.	7.	8.
1.	2.	3.	4.	5.	6.	7.	8.
1.	2.	3.	4.	5.	6.	7.	8.
1.	2.	3.	4.	5.	6.	7.	8.

6. The sixth part of the report is a list of the names of the persons who have been employed during the year.

7. The seventh part of the report is a list of the names of the persons who have been employed during the year.

8. The eighth part of the report is a list of the names of the persons who have been employed during the year.

Comparison of groups 2 and 3 shows that the Columbia x Navajo yearlings, group 3, excelled in both grease and clean fleece weights, and staple length.

Groups 6 and 7 sired by Lincoln and Cotswold rams were similar as regards clean fleece weight and staple length, and were among the heaviest wool producers.

Group 9, sired by Columbia x Navajo rams and out of Cotswold cross ewes, produced more clean wool with slightly more staple length than the reciprocal cross, group 8. Also it will be noted that the ewes of group 10, sired by Romney x Navajo rams and out of Lincoln cross ewes were better wool producers than the reciprocal cross ewes.

Group	No. of ewes	Fleece Weights		Grade	Fiber Traits at Side		
		Grease (lbs.)	Clean (lbs.)		Staple length (cms.)	Kemp (per-cent)	Other med. fibers (percent)
2	38	7.59	3.73	60s	10.6	0.0	0.4
3	42	8.30	4.21	62s	10.9	.2	.5
6	31	8.38	4.18	58s	13.2	.0	.2
7	32	8.72	4.42	60s	13.4	.0	.2
8	32	7.78	3.97	60s	12.3	.0	.7
9	26	8.66	4.26	60s	12.7	.0	.3
10	4	7.87	3.99	62s	11.8	.0	.0
11	14	7.21	3.72	60s	11.3	.0	.0
Total & Averages							
1950	219	8.14	4.09	60s	12.0	.0	.4
Total & Averages							
1949	260	7.06	4.66	60s	10.8	.1	.9

SECTION III

IMPROVEMENT OF NAVAJO SHEEP BY CROSSBREEDING AND SELECTION FOR RANGE PRODUCTION OF WOOL AND LAMBS SUITED TO MARKET REQUIREMENTS

The objective of this project is to develop a strain of sheep that will be well adapted to southwestern range conditions, with inheritance for efficient production of high quality feeder lambs and combing length wool of 60s and 62s grades. This project was initiated in 1948. Crossbred ewes with inheritance of 1/2 Navajo, 1/4 Romney and 1/4 Corriedale were mated with carefully selected rams of the Targhee, New Zealand Merino and Debouillet breeds, and Navajo ewes were mated to a Rambouillet ram to test the relative performance of these crosses under the same environmental conditions.

The characteristics of the breeding ewes and rams and their weanling and yearling progeny are summarized in this section.

CHARACTERISTICS OF PUREBRED BREEDING RAMS

Group	No. of rams	Age of ram at breeding (years)	Average body wt. at breeding time (lbs.)	Fleece Weights as Yearlings		Fiber Traits at Side	
				Grease (lbs.)	Clean (lbs.)	Grade	Staple length (cms.)
12	2	3	214.0	12.50	6.72	64s	12.5
13	1	4	160.0	10.60	7.07	60s	10.9
14	1	2	171.0	15.15	7.18	64s	13.0
15	1 ^{a/}	-	-	-	-	-	-
Total & Averages	5	3	189.8	12.69	6.92	64s	12.2

^{a/} Ram owned by private breeder and fleece records were not obtained.

Body weights and fleece characteristics of the purebred breeding rams used in project 3 are presented in the above summary.

Targhee, New Zealand Merino, Debouillet and Rambouillet rams were used in breeding groups 12, 13, 14 and 15, respectively. All rams were excellent representatives of their breeds, with high yields of clean wool.

CHARACTERISTICS OF NAVAJO AND CROSSBRED BREEDING EWES

The 156 ewes in breeding groups 12, 13 and 14 were selected from that portion of the breeding flock having an inheritance of 1/2 Navajo, 1/4 Romney and 1/4 Corriedale, with fleeces grading 1/2 blood or finer. These ewes were then mated at random to Targhee, Debouillet and Merino rams. In general these ewes had large frames, open faces and were free from wool on the lower legs. The wool was long staple, but lacked density, hence grease and clean fleece weights were comparatively low.

The breeding ewes in group 15 were mated to a Rambouillet ram owned by a private breeder. The 30 ewes were selected at random from the Navajo flock. Their fleeces averaged slightly coarser, longer staple, and contained more kemp and other medullated fibers than those of the crossbred ewes in groups 12, 13 and 14.

Group	No. of ewes	Age of ewes at breeding (years)	Body weight at 18 mos. (lbs.)	Fleece Weights as Yearlings		Grade	Fiber Traits at Side		
				Grease (lbs.)	Clean (lbs.)		Staple length (cms.)	Kemp (per-cent)	Other Med. Fibers (per-cent)
12	62	6.0	106.8	5.54	2.97	60s	8.1	0.0	0.2
13	33	5.9	107.4	5.87	3.23	60s	8.2	.1	.6
14	31	5.9	108.4	5.60	3.07	60s	8.2	.2	.1
15	30	5.3	108.2	4.80	3.11	56s	9.5	.3	2.1
Total & Averages	156	5.8	107.5	5.48	3.07	60s	8.4	.1	.6

LAMB PRODUCTION OF CROSSERED MATINGS

Group	No. of ewes bred	Percent of ewes lambing	Percent of lambs born of ewes bred	Percent of lambs weaned of ewes bred	Percent of lambs weaned of live lambs born	Average weaning weight in pounds	Pounds of lamb per ewe bred
12	62	95.2	136.1	103.3	75.9	44.1	45.5
13	33	3.0	6.1	3.0	50.0	38.8	1.2
14	31	77.4	103.2	71.0	68.8	45.4	32.2
15	30	33.3	53.3	43.3	81.3	51.7	22.4
Total & Averages 1950	156	60.3	85.8	63.9	74.4	45.3	29.0
Total & Averages 1949	128	89.9	131.3	107.3	81.5	62.1	66.5

In the above summary, groups 12, 13 and 14 represent the lamb production of Targhee, Merino and Debouillet rams, respectively, mated to crossbred ewes. Group 15 represents the mating of a Rambouillet ram with Navajo ewes. These matings were initiated in 1949, consequently only the results in 1949 and 1950 are available. The small number of ewes lambing in group 15 is probably due to the fact that the Rambouillet ram used in this breeding pen had been previously mated to over a hundred ewes before he was used with ewes in this pen. The percentage of lambs weaned of live lambs born is greater than the other groups in this summary and compares favorably with all other groups where Navajo ewes were used. This again is an indication of the adaptability of the Navajo sheep under adverse conditions.

Only 3 lambs were born in group 13. The Merino ram, the sire of group 13, apparently became sterile during the breeding season.

FACE AND BODY SCORES OF CROSSBRED WEANLING LAMBS

<u>RAM LAMBS</u>					<u>EW E LAMBS</u>			
Group No.	No. of lambs	Face covering (score)	Type (score)	Condition (score)	No. of lambs	Face covering (score)	Type (score)	Condition (score)
12	29	3.08	2.89	3.76	34	3.07	2.78	3.49
13	1	3.17	2.92	2.79	-	-	-	-
14	10	3.17	3.02	3.47	12	2.71	3.15	3.78
15	7	2.93	3.02	3.90	6	2.42	3.17	3.64
Total & Averages 1950	47	3.07	3.70	2.94	52	2.91	2.91	3.58
Total & Averages 1949	74	3.10	2.52	2.49	63	3.04	2.57	2.39

In the preceding table face and body scores have been summarized by groups, year and sex for research project 3. Very little difference in face covering was evident between sexes within groups or between the two year averages. The Rambouillet - Navajo cross had the least amount of face covering. Type and condition scores for both sexes for 1949 were superior to those for the dry year of 1950. Regarding these two characteristics, the type scores for the ram lambs were more affected by the drouth year than were the ewe lambs, while the condition scores of the ewe lambs were affected more than the ram lambs. Only small differences in the 1950 type and condition scores were evident between breeding groups within sexes.

FLEECE CHARACTERISTICS OF CROSSBRED WEANLING LAMBS

Data on fleece characteristics of 99 weanling lambs produced in breeding groups 12, 13, 14 and 15 are summarized below.

The Targhee cross lambs, group 14, had an average fleece grade of 62s, good staple and less outercoat fibers than the lambs of other groups. Their fleeces were free from kemp and contained but few medullated fibers.

The fleeces of lambs sired by the Debouillet ram averaged one grade finer than the Targhee cross lambs, and were similar with respect to staple length.

The F₁ Rambouillet x Navajo lambs, group 15, had the shortest staple and the highest outercoat score, but showed great improvement in fleece quality as compared with their dams.

Group	No. of lambs	Grade	Fiber Traits at Side			Outercoat (score)
			Staple length (cms.)	Kemp (percent)	Other Med. fibers (percent)	
12	63	62s	3.1	0.0	0.8	2.00
13	1	62s	3.2	.0	.0	2.17
14	22	64s	3.0	.2	1.0	2.20
15	13	64s	2.7	.1	1.0	2.38
Total & Averages 1950	99	62s	3.0	.1	.9	2.10
Total & Averages 1949	137	60s	3.4	.1	.5	2.26

SELECTION PRACTICED ON CROSSBRED WEANLING LAMBS

In the following table, the selection differentials show that positive selection was practiced for most traits considered. However, small negative differentials can be seen for a few of the characteristics. Among the rams the greatest emphasis was placed on weaning weight followed in general by condition and type scores. Among the ewe lambs the greatest emphasis was placed on condition and type followed by weaning weight. Regarding average fiber diameter all lambs were graded half blood or finer, with the group averages grading fine medium (62s). All these lambs saved were within the desired range of fineness.

As in other groups fewer lambs were saved in 1950 than in previous years due to the small size of the lambs at weaning. It was believed these lambs culled would not develop satisfactorily for breeding flock replacements.

SELECTION PRACTICED ON CROSSBRED WEANLING LAMBS

Group No.	Sex		Weaning weight (lbs.)	Staple length (cms.)	Fiber diameter (microns)	Face covering (score)	Body type (score)	Condition (score)	Color (score)	Outer-coat (score)	Percent saved	
12	Rams	Advantage of selected lambs	4.50	.00	.10	.28	.14	.38	-.01	.20	31.03	
		Relative emphasis	.57	.00	.05	.50	.25	.57	-.02	.35		
		Expected genetic gain	1.35	.00	-	.16	.02	.02	.02	-	-	
		Ewes	Advantage of selected lambs	1.82	-.10	.10	.02	.10	.20	.12	.22	64.71
14	Rams	Relative emphasis	.29	-.16	.04	.04	.21	.36	.19	.34		
		Expected genetic gain	1.55	-.04	.10	.01	.01	.01	.01	-	-	
		Ewes	Advantage of selected lambs	5.76	.40	.20	.06	.20	-.04	.60	-.17	30.00
		Relative emphasis	.94	.70	.18	.13	.69	-.11	.56	-.30	-	
	Ewes	Expected genetic gain	1.73	.16	-	.03	.03	.00	-	-		
		Advantage of selected lambs	.90	.20	.70	.12	-.01	.15	.09	.25	75.00	
		Relative emphasis	.11	.31	.39	.26	-.02	.24	.17	.36		
		Expected genetic gain	.27	.08	-	.07	-.01	.01	-	-		
15	Rams	Advantage of selected lambs	13.45	-.20	.20	-.13	-.19	1.10	.00	.07	28.57	
		Relative emphasis	1.29	-.38	.16	-.30	-.51	1.37	.00	.10		
		Expected genetic gain	4.04	-.08	-	-.07	-.02	.04	-	-		
		Ewes	Advantage of selected lambs	1.33	.00	.10	.15	.20	.11	.03	.19	83.33
	Ewes	Relative emphasis	.19	.00	.05	.22	.37	.28	.08	.26		
		Expected genetic gain	.40	.00	-	.08	.03	.00	-	-		
		Advantage of selected lambs	1.33	.00	.10	.15	.20	.11	.03	.19	83.33	
		Relative emphasis	.19	.00	.05	.22	.37	.28	.08	.26		
	Ewes	Expected genetic gain	.40	.00	-	.08	.03	.00	-	-		

BODY WEIGHTS AND SCORES OF CROSSBRED YEARLING RAMS

Group No.	No. of rams	Body weight (lbs.)	Face covering (score)	Type (score)	Condition (score)	Color (score)	Outer-coat (score)
12	14	113.0	2.90	2.38	2.17	1.07	1.44
13	5	111.4	3.23	2.83	2.27	1.40	1.24
14	5	115.8	2.89	2.17	1.90	1.00	1.20
Total & Averages 1950	24	113.3	2.99	2.43	2.13	1.13	1.35

The body weights and scores of the crossbred yearling rams summarized in the above table were too few in numbers to justify a valid comparison between groups. However, only small differences were found between groups for any of the characteristics. The rams of group 14 had the heaviest body weight and the most desirable face covering, type and condition scores.

When compared to the yearling rams in research project 2, these rams were slightly smaller in body weight but nearly equal in type, condition and color scores, and better with respect to outercoat scores. Since these were the first yearling rams produced in these groups, no yearly comparison can be made.

FLEECE CHARACTERISTICS OF CROSSBRED YEARLING RAMS

Staple lengths, grades and fleece weights of yearling crossbred rams, groups 12, 13 and 14, are summarized below.

Group	No. of rams	Fleece Weights		Fiber Traits at Side	
		Grease (lbs.)	Clean (lbs.)	Grade	Staple length (cms.)
12	14	8.92	4.84	60s	11.2
13	5	9.78	5.74	62s	11.8
14	5	8.25	4.20	62s	10.7
Total & Averages	24	8.96	4.89	60s	11.2

The yearling rams produced fleeces that averaged one to two grades coarser in fiber diameter, and yielded from 33 percent to 39 percent more

clean wool than yearling ewes of corresponding groups. In staple length the rams exceeded the ewes by 2.0 to 2.6 centimeters. Differences between ewes and rams were influenced by sex, intensity of selection and environmental conditions. The rams were maintained in dry lots on a ration of alfalfa hay and oats during the late fall and winter months, whereas the ewes were grazed on the range and received only protein supplement.

The yearling rams of group 13, sired by a New Zealand Merino ram, exceeded groups 12 and 14, in clean fleece weight by 0.90 pounds and 1.54 pounds, respectively. The Merino cross rams however, were the least desirable with respect to body size and type.

BODY WEIGHTS AND SCORES OF CROSSBRED YEARLING EWES

Group No.	No. of ewes	Body weight (lbs.)	Face covering (score)	Type (score)	Condition (score)	Color (score)	Outer-coat (score)
12	24	83.2	2.79	2.19	2.16	1.21	1.76
13	14	78.5	2.74	2.25	1.97	1.00	1.46
14	11	83.1	2.71	2.27	2.25	1.18	1.81
Total & Averages	49	81.8	2.76	2.22	2.13	1.14	1.68

The body weights and scores of the yearling crossbred ewes in groups 12, 13 and 14 are summarized in the preceding table. Only small differences were found between groups in any of the characteristics. When compared to the yearling crossbred ewes in research project 2, they had a slightly smaller average body weight, but were superior in all other characteristics.

FLEECE CHARACTERISTICS OF CROSSBRED YEARLING EWES

Fleece weights and fiber characteristics of yearling crossbred ewes produced in groups 12, 13 and 14 are summarized below.

Group	No. of ewes	Fleece Weights		Fiber Traits at Side	
		Grease (lbs.)	Clean (lbs.)	Grade	Staple length (cms)
12	24	8.60	3.56	70s	9.2
13	14	9.13	4.12	64s	9.2
14	11	8.36	3.17	64s	8.7
Total & Averages	49	8.70	3.64	70s	9.1

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The fleeces of the Targhee cross ewes, group 12, had a typical 1/2 blood character, with a tendency toward coarseness at the breech. The average fiber diameter however, was equivalent to grade 70, or two grades finer than the average of the weanling lambs of this cross.

The Merino cross ewes, group 13, ranked well above the other groups in both grease and clean fleece weights, and had good density. Visually, the fleeces appeared to be mainly of 58s quality but measured 64s in fineness.

The fleeces of ewes sired by the Debouillet ram were distinguished by good character but had less staple length than either the Targhee cross or Merino cross ewes.

GRADING AND SORTING OF INDIVIDUAL FLEECES

In 1950 the fleeces of all sheep, except the purebred rams, were graded and sorted individually by two commercial wool sorters from the Wool Division, Production and Marketing Administration.

At shearing time each fleece was wrapped in cheesecloth and identified with the ear tag number of the sheep from which it was shorn. The purpose of wrapping the fleeces in cheesecloth was to prevent loss of pieces of wool and thereby assure greater accuracy to the weights of fleece sorts.

The various main sorts and off sorts of each fleece were weighed individually in grams and recorded by Station employees. As a control measure the weights of main sorts and off sorts of each fleece were totaled on an adding machine, and the combined weight of all sorts was checked against the weight of the whole fleece before it was sorted. By following the procedure with each individual fleece as sorted, errors due to loss of wool at the sorting tables, or in weighing the sorts were held to a minimum.

Fleeces of mature ewes and rams represent 12 months growth, whereas the fleeces of yearling ewes and rams were only 11 months growth.

The weights and grades of all Navajo fleeces are summarized on the following page, by age and sex of the sheep.

SUMMARY OF FLEECE GRADES AND WEIGHTS OF NAVAJO SHEEP

Fleece Grade	Yearling Ewes		Yearling Rams		Mature Ewes		Mature Rams	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
60s/62s					4	5.47		
56s/58s	1	4.42	3	5.57	4	5.09		
50s	1	5.68	3	5.97	6	5.33	1	7.62
46s/48s	7	5.37	3	6.40	33	5.88	1	7.07
44s	14	5.40	1	5.29	87	6.39	2	7.53
40s	9	5.36			81	6.58	2	8.28
36s	12	5.89			129	6.96		
Totals & Averages	44	5.50	10	5.91	344	6.56	6	7.71

The difference in shorn fleece weights between yearling and mature ewes (1.06 lbs.) and between yearling and mature rams (1.80 lbs.) provides an indication of the effect of age. The effect of sex is shown by the difference between yearling ewes and rams (0.41 lbs.) and by the difference between mature ewes and rams (1.15 lbs.). These differences are influenced by previous selections, length of growth period, as well as variation in age of mature ewes and rams. Hence, they represent only rough approximations of the real differences. The fleeces of yearling and mature ewes were graded lower in 1950 than in 1949. For example, 48 percent of the yearling ewe fleeces and 61 percent of the mature ewe fleeces graded either 36s or 40s in 1950. In 1949 however, yearling and mature ewe fleeces grading 36s or 40s amounted to only 23 percent and 40 percent, respectively. The differences between years were probably influenced by the dry condition of the wool in 1950. Differences in grading standards between years may have been another factor.

PERCENTAGES OF SORTS OF NAVAJO FLEECES
CLASSIFIED BY AGE AND SEX OF SHEEP

Description of Sort	Sorts expressed as percentage of total wool for each class of sheep			
	Yearling ewes	Yearling rams	Mature ewes	Mature rams
MAIN SORTS				
Matchings				
64s/80s	0.00	-	0.07	-
60s/62s	.00	-	.44	-
56s/58s	.97	19.42	.75	-
50s	.90	19.05	.98	3.16
46s/48s	7.04	25.40	5.63	17.59
44s	18.29	14.33	15.58	20.66
40s	23.16	1.95	18.86	35.70
36s	24.60	-	28.45	11.65
TOTAL MAIN SORTS	74.96	80.15	70.76	88.76
OFF SORTS				
Tender	0.25	-	0.45	-
Belly	1.06	1.93	1.75	-
Burry	.18	7.33	.96	2.38
Stained	16.54	9.61	6.39	7.50
Paint	1.39	.98	1.00	.75
Kemp	3.93	-	16.22	-
Tags	1.69	-	2.47	.61
TOTAL OFF SORTS	25.04	19.85	29.24	11.21
Total weight (lbs.)	242.22	59.10	2255.06	46.27
Total No. of Fleeces	44	10	344	5
Average Fleece weight (lbs.)	5.50	5.91	6.56	7.71

The fleeces containing the highest percentage of main sorts were produced by the mature rams, followed by yearling rams, yearling ewes and mature ewes, respectively.

Stained wool made up the largest amount of offsort wool for all ages and sexes of Navajo sheep. As the wool is of relatively long staple, and the sheep were not crutched before shearing, a comparatively large amount of stained wool was present.

A substantial number of mature ewe fleeces and a smaller number of yearling ewe fleeces were classed as kempy because of excessive hairiness. This comprises the largest single off-sort from fleeces of Navajo mature ewes. This indicates that an aid to culling sheep for undesirable fleeces may be obtained from the wool sorting records.

Yearling ram fleeces contained the largest percentages of burry and seedy wool. This is due to large amounts of chaff becoming lodged in the fleeces during feeding periods.

PERCENTAGES OF SORTS OF CROSSBRED FLEECES
CLASSIFIED BY AGE AND SEX OF SHEEP

Description of Sort	Sorts expressed as percentage of total wool for each class of sheep			
	Yearling ewes	Yearling rams	Mature ewes	Mature rams
MAIN SORTS				
Matchings				
64s/80s	3.63	2.64	0.05	0.00
60s/62s	6.27	4.78	.40	.00
56s/58s	6.63	8.74	2.24	.00
50s	7.36	10.59	4.03	1.21
46s/48s	11.61	16.97	12.15	.74
44s	19.84	16.63	25.10	18.40
40s	13.08	13.99	20.79	31.49
36s	8.99	5.76	16.16	28.43
TOTAL MAIN SORTS	77.41	80.08	80.92	80.27
OFF SORTS				
Tender	0.39	0.93	0.26	1.89
Belly	5.20	.30	3.91	.20
Burry & Seedy	2.72	5.37	4.31	3.04
Stained	9.84	11.53	4.94	10.29
Paint	.79	.59	.51	.29
Kemp	.21	.73	2.86	3.68
Tags	3.44	.47	2.29	.34
TOTAL OFF SORTS	22.59	19.92	19.08	19.73
Total weight (lbs.)	2242.64	1118.33	8310.62	347.83
Total No. of Fleeces	317	134	920	32

The percentages of main sorts and off sorts obtained from the fleeces of 1403 crossbred sheep are summarized in the preceding table by age and sex classes of the sheep.

Between 19 percent and 20 percent of the total wool from mature ewes, yearling rams and mature rams was classified as off sorts, while yearling ewes had 22.59 percent of off sorts. Most of the difference was due to the greater amounts of the belly sort and tags in the yearling ewes. Stained wool accounted for the highest percentage of off sort in all classes of sheep. Yearling and mature rams had higher percentages of stained wool than either yearling or mature ewes, as the rams were maintained in feed lots during the winter. The percentages of burry and seedy wool from yearling and mature ewes were much lower in 1950 than in 1949, but slightly higher for rams. A major part of the wool classified as burry and seedy contained chaff from hay. Wool with excessive hairiness was classified as kemp in 1950, whereas in previous years no kemp sort was made.

Fleece weights and grades of yearling and mature crossbred ewes and rams are summarized in the following tables by age and sex classes, and breeding projects.

FLEECE GRADES AND WEIGHTS OF CROSSBRED MATURE EWES AND RAMS OF PROJECT 2

Fleece Grade	Groups 6&7 ^{a/}		Group 8		Group 9		Group 10		Group 11		Group 16	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
<u>Ewes</u>												
56s/58s	11	7.92	3	7.40					1	8.36		
50s	20	7.67	8	9.97			1	8.07	4	10.26		
46s/48s	30	7.72	30	10.31	10	7.87	3	9.76	23	9.11	3	10.81
44s	63	7.82	47	10.35	31	8.50	57	9.96	33	8.75	10	9.02
40s	36	8.72	39	10.81	41	9.48	46	10.20	17	9.95	8	9.58
36s	34	8.96	15	10.57	24	9.00	21	10.73	4	9.28	3	11.46
Totals & Averages	194	8.15	142	10.41	106	8.93	128	10.12	82	9.20	24	9.74
<u>Rams</u>												
56s/58s							1	7.24				
50s					1	9.41						
44s			4	10.50	2	12.02	3	9.31			1	10.41
40s			2	10.71			2	10.05	4	12.13	4	10.35
36s			2	11.72	3	12.00	2	10.37	1	14.42		
Totals & Averages			8	10.86	6	11.57	8	9.59	5	12.61	5	10.36

^{a/} Numbers refer to breeding groups.



FLEECE GRADES AND WEIGHTS OF CROSSBRED YEARLING EWES AND RAMS OF PROJECT 2

Fleece Grade	Group 2 No.	Wt.	Group 3 No.	Wt.	Group 6 No.	Wt.	Group 7 No.	Wt.	Group 8 No.	Wt.	Group 9 No.	Wt.	Group 10 No.	Wt.	Group 11 No.	Wt.
<u>Ewes</u>																
60s/62s			1	6.90							1	6.63				
56s/58s	4	6.14	3	6.50									1	5.52	1	5.19
50s	3	5.75	8	7.55			2	4.64			1	6.78			2	5.29
46s/48s	6	7.15	16	7.19	4	8.34	3	6.39	4	6.14	3	7.36			5	6.11
44s	19	6.39	11	7.04	13	7.15	5	7.44	13	6.44	10	7.34	2	6.98	5	6.72
40s	4	7.09	1	8.70	8	6.98	11	8.00	7	7.43	7	7.59				
36s	1	8.44	1	9.01	4	6.96	9	7.80	3	7.90	2	8.19				
Totals & Averages	37	6.57	41	7.24	29	7.24	30	7.40	30	6.76	24	7.44	3	6.49	13	6.15
<u>Rams</u>																
56s/58s			5	8.25	1	7.38										
50s	5	7.26	9	8.84	1	6.30			1	8.34	1	7.76			1	6.45
46s/48s	8	7.86	4	8.36	3	8.03	5	7.22	3	8.23	4	8.10			1	7.79
44s	2	8.78	1	8.37	5	8.81	1	9.30	3	8.12	5	8.42			2	5.84
40s	2	9.34	1	8.56	3	10.41	4	9.80	4	8.16	5	9.30	1	8.41		
36s							2	10.27	2	10.43	1	6.59	1	10.66		
Totals & Averages	17	7.96	20	8.56	13	8.70	12	8.76	13	8.53	16	8.46	4	8.43	5	6.74

a/ Numbers refer to breeding groups.

FLEECE GRADES AND WEIGHTS OF
MATURE CROSSBRED EWES, PROJECT 3 ^{a/}

Fleece Grade	No.	Wt.
64s/80s	1	8.96
60s/62s	7	6.61
56s/58s	24	7.23
50s	18	7.09
46s/48s	33	7.81
44s	38	7.58
40s	3	10.45
Totals & Averages	124	7.52

^{a/} Includes ewes of breeding groups 12, 13 and 14

FLEECE GRADES AND WEIGHTS OF
YEARLING RAMS AND EWES IN PROJECT 3.

Fleece Grade	<u>Group 12</u>		<u>Group 13</u>		<u>Group 14</u>		<u>Group 12</u>		<u>Group 13</u>		<u>Group 14</u>	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
<u>Yearling Ewes</u>						<u>Yearling Rams</u>						
64s/80s	7	6.38	1	6.48	4	6.96	1	8.45	1	9.05	4	7.33
60s/62s	6	8.30	3	8.19	5	6.95	5	7.85	2	8.69	1	8.16
56s/58s	3	7.92	3	6.98			7	7.85	1	9.24		
50s	4	7.94	3	8.14			1	10.40				
46s/48s	2	7.46	2	8.02					1	8.70		
Totals & Averages	22	7.51	12	7.70	9	6.95	14	8.07	5	8.87	5	7.50

DISPOSITION OF WOOL, NOVEMBER 1, 1949 THROUGH OCTOBER 31, 1950

At the beginning of the period covered by this report, 10,236 pounds of grease wool and 3,424 pounds of scoured wool were on hand. Disposition of wool is shown in the following table. The 1950 wool clip increased the grease wool inventory by 14,590 pounds. At the end of the year covered by the report, a total of 20,585 pounds of grease wool and 1,732 pounds of scoured wool were on hand.

DISPOSITION OF WOOL, NOVEMBER 1, 1949 THROUGH OCTOBER 31, 1950

	Wool Sales			Samples drawn for research (lbs.)	Blanket mfg.test (lbs.)	Totals (lbs.)
	Traders (lbs.)	Indians (lbs.)	Schools (lbs.)			
Grease matchings	3289.50	84.90	70.00	160.00	17.00	3621.40
Grease off sorts	293.00	94.50	-	70.00	-	457.50
Scoured matchings	750.30	72.75	-	12.00	583.00	1418.05
Scoured off sorts	20.00	-	-	-	200.00	220.00
Unsorted fleeces	30.00	82.25	30.00	-	-	162.25
Yarn	-	2.72	-	-	-	2.72
TOTALS	4402.80	337.12	100.00	242.00	800.00	5881.92

SALES OF RAMS DURING 1950

A total of 77 crossbred breeding rams were sold during 1950 for use by Navajo Indians. All of the rams were yearlings except 8 that were either 2 or 3 years of age. These rams were produced from matings in breeding groups 2, 3, 6, 7, 8 and 9.

Following is a summary of the ram sales by districts of the Navajo Reservation:

<u>District</u>	<u>Number of rams</u>
8	7
9	33
11	3
12	8
13	4
14	8
16	6
17	2
18	1
Other <u>a/</u>	5

a/ Points adjacent to Navajo Reservation.



